

REMARKS

In the Action, claims 1-3 and 5-9 are rejected. In response, claim 1 is amended, and new claims 11-13 are added. The pending claims in this application are claims 1-3, 5, 6, and 8-13, with claim 1 being the sole independent claim.

Claim 1 is amended to clarify that the reaction liquid from the reaction apparatus is introduced into a distillation apparatus to obtain a distillate containing unreacted (meth)acrylic acid, recovering the distillate containing the unreacted (meth)acrylic acid and thereafter recycling and introducing the distillate into the reaction apparatus. Support for these features is found on pages 12 and 14 of the specification. New claim 11 depends from claim 1 to recite the step of directly transferring the distillate from the distillation apparatus to the reaction apparatus. Claim 12 depends from claim 1 to recite the step of transferring the distillate from the distillation apparatus to an intermediate tank and thereafter transferring the distillate directly from the intermediate tank to the reaction apparatus. Claim 13 depends from claim 1 and recites the reaction being continuous as disclosed on page 16, lines 14-16. These steps are not disclosed or suggested in the art of record.

In view of these amendments and the following comments, reconsideration and allowance are requested.

Rejection Under 35 U.S.C. § 103(a)

The claims are rejected as being obvious under 35 U.S.C. § 103(a) over U.S. Patent No. 6,414,182 to Shingai et al. The Action contends that Shingai et al. teaches the elements of the claimed invention with sufficient guidance that the invention would be obvious to one of ordinary skill in the art.

As recognized in the Action, Shingai et al. does not disclose distilling the reaction liquid to recover unreacted (meth)acrylic acid. Furthermore, Shingai et al. does not disclose recovering unreacted (meth)acrylic acid by distillation and thereafter recycling the recovered (meth)acrylic acid to the reaction vessel. The Action refers to column 2, lines 36-39. This passage of Shingai et al. clearly distinguishes between the step to remove unreacted residues of raw materials and the final purification step to obtain the hydroxyalkyl ester. In particular, Shingai et al. recites a step to remove the unreacted residues of raw materials from the reaction liquid “and then” purifying the reaction liquid such as by distillation in a subsequent final step. Thus, it is clear that the passage of Shingai et al. discloses separating the unreacted residues by conventional methods such that the resulting reaction liquid contains little or no unreacted residue. Only after the unreacted residues are removed is the reaction liquid distilled to purify the hydroxyalkyl ester.

Shingai et al. does not suggest distilling the reaction liquid containing unreacted residues to recover the unreacted residues. Furthermore, Shingai et al. provides no suggestion to one of ordinary skill in the art that unreacted residues and particularly unreacted (meth)acrylic acid can be recovered by distillation. Shingai et al. and one skilled in the art do not recognize that the unreacted (meth)acrylic acid can be recovered by distillation. The distillation renders the separation step of Shingai et al. unnecessary and superfluous. The present invention is directed to the discovery that the separation step of Shingai et al. is unnecessary and can be eliminated by passing the reaction liquid directly to a distillation column and recovering the distillate, and thereafter recycling the distillate to the reaction apparatus. The separation step of Shingai et al. is considered essential for recovering the unreacted residues to be recycled. Eliminating a step that is considered necessary in the prior

art is not obvious to one of ordinary skill in the art. Accordingly, the claims are not obvious over Shingai et al.

Shingai et al. fails to disclose or suggest the process of claim 1 as amended. Claim 1 recites the process of introducing the reaction liquid from the reaction apparatus to a distillation apparatus and recovering a distillate containing unreacted (meth)acrylic acid, recovering the distillate and recycling and introducing the distillate containing the unreacted (meth)acrylic acid to the reaction apparatus. These features are not disclosed or suggested in Shingai et al.

Claim 1 also recites the operational pressure during the distillation of the reaction liquid. The operational pressure is selected to recover the unreacted (meth)acrylic acid. As noted above, the distillation of Shingai et al. is carried out after the unreacted residues are removed. Therefore, Shingai et al. does not suggest the claimed operational pressure for recovering unreacted (meth)acrylic acid since the unreacted residues of Shingai et al. were previously removed.

The passages referred to in the Action disclose generally that unreacted reactants can be recovered without providing any specific teaching of how the unreacted reactants and particularly the unreacted (meth)acrylic acid are recovered. As recognized in the Action, Shingai et al. discloses a first step of separating the unreacted (meth)acrylic acid by conventional methods followed by a subsequent second step of distilling the reaction mixture to obtain purified hydroxyalkyl (meth)acrylate. Shingai et al. provides no suggestion that the distillate contains unreacted reactants or that the distillate can be recycled. Shingai et al. clearly fails to disclose that unreacted (meth)acrylic acid can be recovered by distillation. The Action suggests that it would be obvious to distill the reaction mixture to recover unreacted (meth)acrylic acid. However, this position is inconsistent with the disclosure of

Shingai et al. The first recovery step of Shingai et al. would be unnecessary if it were recognized by those skilled in the art that unreacted (meth)acrylic acid can be recovered by distillation. Shingai et al. provides no suggestion or motivation to one of ordinary skill in the art to distill a reaction mixture that is drawn directly from the reaction vessel and that still contains unreacted (meth)acrylic acid.

Shingai et al. does not disclose a specific means or method for recovering the unreacted (meth)acrylic acid. Purifying the hydroxyalkyl ester by distillation provides no suggestion to one of ordinary skill in the art that the impurities or unreacted (meth)acrylic acid can be recycled to the reaction vessel. Shingai et al. provides no motivation or incentive to distill the reaction mixture and recovering the unreacted (meth)acrylic acid in a distillate where the distillate is recycled to the reaction apparatus.

As disclosed on page 2 of the specification, (meth)acrylic acid has a strong affinity for a hydroxyalkyl (meth)acrylate. The low relative volatility of (meth)acrylic acid renders the recovery of unreacted (meth)acrylic acid by distillation difficult to carry out. Thus, Shingai et al. suggests the conventional methods for recovering (meth)acrylic acid. Shingai et al. provides no suggestion that (meth)acrylic acid can be effectively recovered by a distillation without the conventional stripping methods. The invention is directed to the discovery that the reaction liquid containing unreacted (meth)acrylic acid, unreacted alkylene oxide and the resulting hydroxyalkyl (meth)acrylate can be distilled to recover unreacted (meth)acrylic acid where the distillate can be recycled.

For the reasons discussed above, it is not obvious to one of ordinary skill in the art to distill the reaction liquid containing unreacted (meth)acrylic acid, unreacted alkylene oxide and the resulting hydroxyalkyl (meth)acrylate to recover unreacted (meth)acrylic acid. It is also not obvious to recycle the distillate containing unreacted (meth)acrylic acid to the

reaction vessel as claimed. Shingai et al. also does not disclose the distillation at an operational pressure of 0.1 to 40 hPa to recover the unreacted (meth)acrylic acid. Since conventional methods do not recover unreacted (meth)acrylic acid by distillation and in view of the low volatility of (meth)acrylic acid, the claimed pressure during distillation of the reaction mixture is not obvious to one of ordinary skill in the art. The significance of the pressure is demonstrated in Comparative Example 1 and Comparative Example 2 of the specification. The distillation of the reaction mixture can cause clogging of the distillation column by the formation of a polymerized product when the pressure is above the claimed range. Uncondensed vapor can also form in the top of the condenser which can be difficult to recover when the operating pressure is below the claimed range. In view of the properties of (meth)acrylic acid and the affinity for hydroxyalkyl (meth)acrylate, the claimed operating pressure is not obvious over Shingai et al.

The claims depending from claim 1 are also allowable for reciting additional steps of the invention which in combination with the process steps of claim 1 are not disclosed in Shingai et al. Shingai et al. does not disclose recovering unreacted alkylene oxide together with the unreacted (meth)acrylic acid by distillation and recycling the recovered unreacted materials as in claim 2, recovering the unreacted alkylene oxide from the reaction liquid, and thereafter recovering unreacted (meth)acrylic acid by distillation in a second separate step as in claim 3. Shingai et al. clearly fails to disclose or suggest two distillation steps where the alkylene oxide is recovered in a first distillation step and the unreacted (meth)acrylic acid is recovered in a subsequent distillation step. Accordingly, claim 3 is not obvious over Shingai et al.

Shingai et al. does not disclose distilling the reaction liquid with a plate column and/or packed column as in claim 5, the use of polymerization inhibitors during the distillation step as in claim 6 in combination with the process steps of claim 1.

Claim 8 recites the steps of recovering the unreacted (meth)acrylic acid by distillation and thereafter purifying the resulting reaction liquid containing the crude hydroxyalkyl (meth)acrylate. Shingai et al. does not disclose these steps. Instead, Shingai et al. discloses a first step of recovering unreacted reactants and thereafter purifying the hydroxyalkyl (meth)acrylate. Shingai et al. provides no suggestion of a subsequent purification step after the distillation step of claim 8. Claim 9 depends from claim 8 to recite the second purifying step being a second distillation step. Shingai et al. does not disclose a first distillation step to recover unreacted (meth)acrylic acid and a second distillation step to purify the resulting reaction mixture. Accordingly, claims 8 and 9 are not obvious over Shingai et al. Claim 10 depends from claim 1 to recite the step of continuously recycling unreacted (meth)acrylic acid from the distillation step through the reaction apparatus as a raw material. As discussed above, Shingai et al. does not disclose distillation of the reaction mixture to recover unreacted (meth)acrylic acid and thus does not disclose continuously recycling unreacted (meth)acrylic acid from a distillation step. Accordingly, claim 10 is not obvious over Shingai et al.

As noted above, Shingai et al. only suggests a conventional separation step of the reaction liquid. Shingai et al. does not suggest directly transferring the distillate from the distillation apparatus to the reaction apparatus as in claim 11, transferring the distillate from the distillation apparatus to an intermediate tank and thereafter transferring the distillate directly from the intermediate tank to the reaction apparatus as in claim 12, or the continuous reaction as in claim 13, in combination with the process steps of claim 1. Accordingly, claims 11-13 are not obvious over Shingai et al.

In view of the above comments, the claims are allowable over the art of record.

Reconsideration and allowance are requested.

Respectfully submitted,



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